THURSDAY, MAY 22, 1879

MILNE'S CRYSTALLOGRAPHY

Notes on Crystallography and Crystallophysics. By John Milne, F.G.S. (London: Trübner and Co., 1879.)

THAT two little treatises should have appeared, written at so near a date the one to the other as Mr. Gurney's and Mr. Milne's introductory tracts on crystallography, shows that there is at least some want at last beginning to be felt for the means of studying that important but somewhat neglected science.

And it is suggestive of some singular reflections that one of these little treatises should come from Japan written by one of that teaching body at Yedo, of which Prof. Perry is a distinguished member.

Is there a demand springing up among the subjects of the Mikado for branches of knowledge which have hardly obtained a footing in institutions in which scientific training is given in Great Britain? Or is it that the Japanese have enticed to their colleges Englishmen who are so far ahead of their colleagues at home, that they are less trammelled by routine, and endeavour in the instruction they give to the youth of Japan to work out a more complete and comprehensive curriculum for the student of chemical science and physics than is recognised at home? Whatever be the cause, we have, in Mr. Milne's little treatise as we had before in Mr. Gurney's, an attempt to supply an educational want. We must award to Mr. Milne all the credit which is his due for the intention this attempt involves, and for his courage in undertaking it, with what was apparently a small and inadequate equipment either in previous study or in the literary material necessary for making his treatise thorough and worthy of the purpose that suggested it. The book is concise and its form fairly well planned; and if our praise cannot be extended to the execution of that plan the circumstances under which the little volume has been produced have to be considered in extenuation of the dispraise. But in criticising it, it is essential to consider its seventy pages solely on their merits. Like Mr. Gurney, Mr. Milne follows Prof. Miller's system of crystallographic notation, and endeavours to make clear the simplicity and elegance of that system. His first line, however, in explanation of the system, the sixth line of his Introduction, is, to say the least, infelicitous. "In this (Miller's) system," he says, "the symbols of a face consist of three whole numbers, each of which invariably refer to the same axes;" a sentence in which are compendiously represented the faults of the book, faults due partly to inaccuracy of mathematical conception, and partly to a mode of employing the English language, for which perhaps some excuse is to be found in a long residence in Yedo, but which surely one of the three home-editors, Mr. T. Davies, Mr. H. Woodward, and Prof. Morris, might have taken the liberty of correcting.

What Mr. Milne intended to convey in the above ungrammatical sentence was, of course, that the symbol for a plane is constituted by three whole numbers termed indices, which may include one or two zeros; the particular axis to which an index has reference being given by the position of the index in the symbol. If Mr. Milne would, for instance, consider the application of his statement to the symbols for the faces y, y', &c., of the crystal of cuprite, which he discusses on p. 27, and where by the by he makes the blunder in his result of putting (015) for (051), he would find that his statement amounts to the assertion that these two last symbols are identical, an assertion that would reduce the system of Miller to all the ineptitude of that of Naumann.

In deducing on p. 16 the symbol of a zone from the symbols of the planes belonging to it the author proceeds on the tacit assumption that he has rectangular axes to deal with, thus leaving unexplained the case of crystals belonging to systems referred to oblique axes; and these form a large majority of the known crystals.

In his mode of treating the problem by algebraic geometry in the last paragraphs on p. 17 he is certainly not to be congratulated.

It is from this p. 17 that one begins to find the hopelessness of this little book fulfilling, in its present crude form, the purpose its author proposes for it; that, namely, of making the simple system of F. Neumann and Miller intelligible either to the student slenderly equipped with mathematical knowledge, or to the votary, too often the partizan of the system of K. Naumann.

For it is evident that Mr. Milne has been unfortunate in his English editors. Mr. T. Davies, a gentleman universally esteemed for his personal character as well as for a very complete familiarity with minerals and rocks, obtained by the daily handling and scrutiny of them during twenty years of service in the British Museum, undertook, it seems, to pass through the press the little book of which copies lithographed by a Japanese native had been sent home to him and to others by Mr. Milne. If Mr. T. Davies had enlisted the aid of some one who possessed a rudimentary knowledge of algebra and plane trigonometry he might have saved Mr. Milne's little book from being useless. Then probably 00 – 01; 00 – 10; 11 – 00 would have been written 0 × 0 – 0 × 1, &c., and would have been intelligible, and such a misprint as that on p. 21, "∴ (112) being (*sic*) the indices of the plane at ⊥ s to [111] and [110]," might have been avoided. Of course a plane ⊥^{r} to [111] and [110] is ($\bar{1}$10) or (1$\bar{1}$0) and not (112); but Mr. Milne meant to write the two zones as [11$\bar{1}$] and [$\bar{1}$10]. Misprints of this serious kind are very numerous; other instances are (loh) for ($lo\tilde{h}$), (orq) for ($or\tilde{q}$), or ($p - s$) for $o, r(p - s)$ on p. 22; ¦Wvw for UVW on p. 24; [312] twice for [$\bar{3}$12] on p. 26; the frequent omission of brackets where they are necessary: for instance, $a^2kr - lq$ instead of $a^2(kr - lq)$ on p. 17; and these are the sort of errors which puzzle a student who is not a fair mathematician, precisely the student for whom the book is meant, since any one possessed of a little mathematical knowledge would naturally prefer to have recourse to Miller's Tract on Crystallography, a book of the existence of which Mr. Milne seems to be unaware, to judge from a note on p. 34. In a treatise on a science which presents to the student novel forms of notation the want of even the most elementary acquaintance with algebra that has allowed the introduction into the type, of

a comma to represent the sign of multiplication in almost every equation, invests the expressions with a hopeless obscurity; what for instance would a young student fresh from a little algebra make of the expression (p. 30), cos PC = cos PA, cos CA + sin PA, sin CA, cos PAC whence PC? Mr. Milne's editors and not Mr. Milne are of course to blame for this, though most of the other mistakes alluded to are his own.

In a chapter on the projection of poles by the stereographic method Mr. Milne gives a proposition for finding a pole [he means the projection of a pole] at given angular distances from two poles lying on the circle of projection, which is only a special and simple case of the more general problem. The description of the process is entirely unintelligible. If, however, the meaning be puzzled out from the figure it would seem that Mr. Milne is proposing a construction simple and ingenious, although to obtain it he has to combine the orthographic and stereographic projections. His editors might have saved him from using the expression "two half-hemispheres" on p. 38, if not also from the statement that the monosymmetric or monoclinic system can present eight faces for a single form. The chapter on crystallophysics is very unsatisfactory; after one's expectations of somewhat transcendental physics have been raised by being told that for the correlation of the phenomena produced by crystals with crystal-structure, "the most valuable hypothesis would probably be that of molecular vortices," one is certainly surprised to be told that in the orthorhombic, monoclinic, and triclinic systems "there are two optic axes or directions of double refraction"—or again, that "sections in triclinic crystals cut perpendicularly to the optic axes when viewed in a polariscope show a series of rings round each axis. Between the axes these are drawn together and may meet to form a lemniscate." One is inclined to ask whether Mr. Milne has a distinct idea as to what a lemniscate curve is, and how he cuts the section presenting these phenomena?

In speaking of heat conductivity again, the author places the rhombohedral and orthorhombic systems together in one category, and the tetragonal system in another. The errors, often arising in carelessness but sometimes in ignorance, to which these criticisms apply, have been selected merely at random. It has been necessary, however, to make these criticisms in the interest of the student, who might be repelled from a subject when he finds what should be a simple statement apparently untrue or unintelligible, whether on account of misprints or of obscurity in the language, in the thought, or in the author's method of demonstration. But having performed this duty to the student of a beautiful but much neglected science it would be ungenerous to a teacher in far Japan, not to point out that it is still within his power by recasting his little volume to fill a decided gap in our elementary scientific literature. He has the courage and the ability, he needs only a little more familiarity with the subject, a good deal more caution, and perhaps somewhat more of modesty, to enable him to fulfil the not very ambitious purpose he laid down for himself when he sent his little work to be published in England.

N. S. M.

MATHEMATICAL PROBLEMS

I. *Mathematical Problems on the First and Second Divisions of the Schedule of Subjects for the Cambridge Mathematical Tripos Examination.* Devised and arranged by Joseph Wolstenholme, M.A. Second Edition, greatly enlarged. (London: Macmillan and Co., 1878.)

II. *Solutions of the Cambridge Senate-House Problems and Riders for the Year* 1875. Edited by A. G. Greenhill, M.A. (Same Publishers, 1876.)

III. *The Same for the Year* 1878. Edited by J. W. L. Glaisher, F.R.S. (Same Publishers, 1879.)

IV. *Graduated Exercises in Plane Trigonometry.* Compiled and arranged by J. Wilson, M.A., and J. R. Wilson, B.A. (Same Publishers, 1879.)

V. *Geometrical Deductions, Riders, and Exercises, based upon Euclid, Books I.—IV.* (Stewart's Mathematical Series, 1878.)

A COMMON purpose pervades these five works, viz., that of affording practice and aid in the solution of mathematical problems. Prof. Wolstenholme, with a marvellous versatility which has long placed him in the foremost rank of "ten-minute conundrum" makers, sends forth a volume (I.) which now contains 2,815 problems in place of the 1,628 which he published in 1867. Further, his book has increased in all the directions in which it is possible for a book to grow, and the number of valuable hints scattered throughout the volume has been greatly enlarged. Dipping into the book here and there we are fain to cry out "Prodi-gi-ous!" with worthy Dominie Sampson, and to think this problem-compelling Briareus ever

> "Agitates his anxious breast,
> In solving problems mathematic."

We have long used the earlier work with profit to ourselves, and, we believe, to the advantage of our pupils preparing for Cambridge scholarship examinations; this new edition is an improvement upon the old, and in its line seems now perfect. What we would much like to have is Prof. Wolstenholme's solutions of his questions, but we fear the public, needed for the purchase of such a work, is not yet in existence. Doubtless there are many errors in the text, but these can only be found out by a free and long-extended use; however, we have noted in question 443, for the second $\cos^3\theta$ read $\sin^3\theta$; question 925, for a ? $2a$; p. 192, lines 2, 5, put – before Δ.

In the volumes II., III., we have a welcome revival of a fashion which has of late years died out; it never prevailed to any great extent, but its occurrence was generally traceable to the influence of some one or two enthusiasts, who, for the benefit of junior students, were willing to put upon record neat solutions of elegant problems, not counting the cost of publication. Such collections as these are especially valuable, and the volumes before us seem quite equal to their predecessors in the same field. A novelty in III. is the publication of additional remarks on some of the questions. For instance, a concise general statement of the method of least squares is given on pp. 162-169; on p. 8 is a note on circulating decimals, and similar notes occur elsewhere. In this work (III.) we have detected several small errors, p. 13 line 14 insert – before $\frac{3}{16}a^2$; p. 14